CLAIMS

1. A system for processing biomass, comprising:

a water-impermeable bottom liner;

a gravel layer supported by the bottom liner;

a drain pipe disposed within the gravel layer;

a biomass input device operable to deliver biomass over the gravel layer to form a biomass pile;

a lime input device operable to deliver lime to the biomass for pretreating the biomass;

a distribution pipe elevated above the gravel layer; and

a pump operable to circulate water through the biomass pile by delivering water to the distribution pipe and receiving water from the drain pipe after it has traveled through the biomass pile.

2. The system of Claim 1, wherein the biomass is lignocellulosic biomass.

3. The system of Claim 1, wherein the lignocellulosic biomass is selected from the group consisting of bagasse and corn stover.

4. The system of Claim 1, wherein the gravel layer is approximately three feet thick.

5. The system of Claim 1, wherein the lime input device is operable to deliver lime to the biomass either during or after the delivering of the biomass over the gravel layer.

6. The system of Claim 1, wherein the lime input device is operable to deliver lime to the biomass in an amount between approximately 10% and 30% of the biomass by weight.

7. The system of Claim 1, further comprising an inoculum input device operable to deliver an inoculum to the biomass pile for fermentation of the biomass pile.

8. The system of Claim 1, further comprising a heat exchanger coupled to the distribution pipe and operable to control a temperature of the water that is delivered to the distribution pipe.

9. The system of Claim 1, further comprising an air blower and an air distribution pipe operable to deliver air to the biomass pile.

10. The system of Claim 9, further comprising a container of lime water slurry coupled to the air distribution pipe and operable to scrub the air of carbon dioxide before the air is delivered to the biomass pile.

11. The system of Claim 1, further comprising a calcium carbonate input device operable to deliver calcium carbonate to the biomass for pretreating the biomass.

12. A system for processing biomass, comprising:

a water-impermeable bottom liner;

a grid-like lattice structure coupled to the bottom liner to form a roof;

a geomembrane coupled to the grid-like lattice structure;

a gravel layer supported by the bottom liner;

a plurality of drain pipes disposed within the gravel layer;

a conveyor belt coupled to the top liner and operable to deliver biomass over the gravel layer to form a biomass pile;

a lime input device operable to deliver lime to the biomass for pretreating the biomass;

a plurality of distribution pipes coupled to the top liner and associated with respective ones of the plurality of drain pipes; and

a plurality of pumps coupled to respective ones of the plurality of drain pipes and respective ones of the plurality of distribution pipes, the pumps operable to circulate water through the biomass pile by delivering water to the distribution pipes and receiving water from the drain pipes after the water has traveled through the biomass pile.

13. The system of Claim 12, wherein the biomass is lignocellulosic biomass selected from the group consisting of bagasse and corn stover.

14. The system of Claim 12, wherein the grid-like lattice structure is formed from a plurality of I-beams in a general shape of a half cylinder.

15. The system of Claim 12, further comprising a foam layer coupled to an outside of the geomembrane.

16. The system of Claim 12, further comprising a sugar extraction device operable to extract sugar from a raw feedstock to produce the biomass.

17. The system of Claim 16, wherein the raw feedstock is selected from the group consisting of energy cane and sweet sorghum.

18. The system of Claim 16, wherein the sugar extraction device comprises a plurality of adjacent extraction tanks, each extraction tank comprising:

a screw conveyor operable to deliver solid material from the raw feedstock an a downstream direction; and

a weir operable to deliver liquid material from the raw feedstock in an upstream direction.

19. The system of Claim 12, wherein the lime input device is operable to deliver lime to the biomass either during or after the delivering of the biomass over the gravel layer.

20. The system of Claim 12, further comprising an inoculum input device operable to deliver an inoculum to the biomass pile for fermentation of the biomass pile.

21. The system of Claim 12, further comprising a heat exchanger coupled to the distribution pipe and operable to control a temperature of the water that is delivered to the distribution pipe.

22. The system of Claim 12, further comprising an air blower and an air distribution pipe operable to deliver air to the biomass pile.

23. The system of Claim 22, further comprising a container of lime water slurry coupled to the air distribution pipe and operable to scrub the air of carbon dioxide before the air is delivered to the biomass pile.

24. The system of Claim 12, further comprising a calcium carbonate input device operable to deliver calcium carbonate to the biomass for pretreating the biomass.

25. A system for processing biomass, comprising:

an end wall;

a water-impermeable bottom liner;

a top liner coupled to the bottom liner, the top liner selectively inflatable by one or more fans coupled to the end wall;

a plurality of water pouches coupled to the top liner, the water pouches selectively inflatable when the top liner is inflated;

a gravel layer supported by bottom liner and separated into a plurality of gravel segments;

a plurality of drain pipes disposed within respective ones of the gravel segments;

a conveyor belt associated with the end wall and operable to deliver biomass over the gravel segments to form a biomass pile;

a lime input device operable to deliver lime to the biomass for pretreating the biomass;

a plurality of distribution pipes coupled to the top liner and associated with respective ones of the plurality of gravel segments; and

a plurality of pumps coupled to respective ones of the plurality of drain pipes and respective ones of the plurality of distribution pipes, the pumps operable to circulate water through the biomass pile by delivering water to the distribution pipes and receiving water from the drain pipes after the water has traveled through the biomass pile.

26. The system of Claim 25, wherein the biomass is lignocellulosic biomass selected from the group consisting of bagasse and corn stover.

27. The system of Claim 25, further comprising an opening formed in the end wall for unloading residue left over from the biomass pile after fermentation.

28. The system of Claim 25, further comprising a sugar extraction device operable to extract sugar from a raw feedstock to produce the biomass.

29. The system of Claim 28, wherein the raw feedstock is selected from the group consisting of energy cane and sweet sorghum.

30. The system of Claim 28, wherein the sugar extraction device comprises a plurality of adjacent extraction tanks, each extraction tank comprising:

a screw conveyor operable to deliver solid material from the raw feedstock an a downstream direction; and

a weir operable to deliver liquid material from the raw feedstock in an upstream direction.

31. The system of Claim 25, wherein the lime input device is operable to deliver lime to the biomass either during or after the delivering of the biomass over the gravel layer.

32. The system of Claim 25, further comprising an inoculum input device operable to deliver an inoculum to the biomass pile for fermentation of the biomass pile.

33. The system of Claim 25, further comprising a heat exchanger coupled to the distribution pipe and operable to

control a temperature of the water that is delivered to the distribution pipe.

34. The system of Claim 25, further comprising an air blower and an air distribution pipe operable to deliver air to the biomass pile.

35. The system of Claim 34, further comprising a container of lime water slurry coupled to the air distribution pipe and operable to scrub the air of carbon dioxide before the air is delivered to the biomass pile.

36. The system of Claim 25, further comprising a calcium carbonate input device operable to deliver calcium carbonate to the biomass for pretreating the biomass.

37. A system for processing biomass, comprising:

a plurality of geodesic domes arranged in a generally circular pattern, each geodesic dome comprising:

a water-impermeable bottom liner;

a top liner coupled to the bottom liner;

a gravel layer supported by the bottom liner;

a drain pipe disposed within the gravel layer; and

a distribution pipe elevated above the gravel layer;

a plurality of pumps coupled to respective ones of the plurality of geodesic domes, each pump operable to circulate water through its respective geodesic dome by delivering water to the distribution pipe associated with the respective geodesic dome and receiving water from the drain pipe associated with the respective geodesic dome;

a rotatable conveyor belt surrounded by the geodesic domes and operable to deliver biomass to each geodesic dome; and

a lime input device operable to deliver lime to the biomass for pretreating the biomass.

38. The system of Claim 37, wherein the biomass is lignocellulosic biomass selected from the group consisting of bagasse and corn stover.

39. The system of Claim 37, wherein each top liner comprises a plurality of hexagonal or pentagonal panels coupled to one another with lips associated with each panel.

40. The system of Claim 37, further comprising a foam layer coupled to an outside of the top liner.

41. The system of Claim 37, wherein the lime input device is operable to deliver lime to the biomass either during or after the delivering of the biomass over the gravel layer.

42. The system of Claim 37, further comprising a calcium carbonate input device operable to deliver calcium carbonate to the biomass for pretreating the biomass.

43. A system for processing biomass, comprising:

a fermenter structure configured to:

accept and store untreated lignocellulosic biomass;

pretreat the lignocellulosic biomass with lime at a temperature between approximately 25°C and 95°C at ambient pressure for a time period of at least approximately four weeks; and

treat the lignocellulosic biomass with an inoculant.

44. A method of biomass pretreatment comprising:

adding an alkali to biomass with lignin content to produce a mixture; and

incubating the mixture at a temperature between approximately 25°C and 95°C at ambient pressure.

45. The method of Claim 44, further comprising incubating the mixture for a time period of at least approximately 4 weeks.

46. The method of Claim 44, further comprising incubating the mixture for a time period of between approximately 4 and 16 weeks.

47. The method of Claim 44, further comprising selecting the duration of incubation based on incubation temperature.

48. The method of Claim 44, wherein the biomass comprises lignocellulosic biomass.

49. The method of Claim 44, wherein the biomass comprises agricultural waste.

50. The method of Claim 44, wherein the biomass is selected from the group consisting of:

bagasse, corn stover and combinations thereof.

51. The method of Claim 44, further comprising circulating water through the biomass during incubation.

52. The method of Claim 44, further comprising circulating air through the biomass during incubation.

53. The method of Claim 44, further comprising circulating oxygen enriched air through the biomass during incubation.

54. The method of Claim 44, wherein the alkali comprises lime.

55. The method of Claim 44, wherein the alkali comprises calcium oxide.

56. The method of Claim 54, further comprising adding approximately 0.5 grams of lime per gram of biomass to produce the mixture.

57. The method of Claim 54, further comprising adding approximately 0.1 to 0.5 grams of lime per gram of biomass to produce the mixture.

58. The method of Claim 54, further comprising adding lime to the biomass in an amount between approximately 10% and 30% of biomass by weight.

59. The method of Claim 44, further comprising adding calcium carbonate to the mixture.

60. The method of Claim 44, further comprising incubating the mixture at a temperature between approximately 25°C and 90°C.

61. The method of Claim 44, further comprising incubating the mixture at a temperature between approximately 25°C and 57°C.

62. The method of Claim 44, further comprising selecting the incubation temperature based on the partial pressure of water at the selected temperature.

63. The method of Claim 44, further comprising increasing the enzyme digestibility of the biomass.

64. The method of Claim 44, further comprising producing pulp.

65. The method of Claim 64, further comprising producing pulp suitable for paper or cardboard production.

66. The method of Claim 44, further comprising reducing the lignin content of the biomass.

67. The method of Claim 66, further comprising reducing lignin content by at least approximately 98%.

68. The method of Claim 66, further comprising reducing lignin content by at least approximately 90%.

69. The method of Claim 66, further comprising reducing lignin content by at least approximately 29%.

70. The method of Claim 66, further comprising reducing lignin content by at least approximately 40%.

71. The method of Claim 66, further comprising reducing lignin content by at least approximately 67%.

72. The method of Claim 66, further comprising reducing lignin content by alkaline oxidation.

73. The method of Claim 44, further comprising fermenting the biomass after incubation.

74. The method of Claim 73, further comprising adding an inoculum to the mixture after incubation.

75. The method of Claim 73, further comprising collecting carboxylate salts from the mixture.

76. The method of Claim 73, further comprising placing the mixture prior to incubation in a storage facility suitable for incubation and fermentation.

77. A method for producing enzymatically digestible biomass comprising:

adding lime to biomass with lignin content to produce a mixture;

incubating the mixture at a temperature between approximately 25°C and 55°C at ambient pressure for a time period of at least approximately 4 to 16 weeks;

circulating water through the mixture during incubation.

78. The method of Claim 72, further comprising circulating air through the mixture during incubation.

79. The method of Claim 77, further comprising reducing the lignin content of the biomass by at least approximately 67%.

80. The method of Claim 22, further comprising reducing the lignin content of the biomass by at least approximately 32%.

81. The method of Claim 22, further comprising fermenting the biomass after incubation.

82. A method for producing pulp comprising:

adding lime to biomass with lignin content to produce a mixture;

incubating the mixture at a temperature between approximately 45°C and 55°C at ambient pressure for a time period of approximately 10 weeks;

circulating water through the mixture during incubation.

83. The method of Claim 82, further comprising circulating air through the mixture during incubation.

84. The method of Claim 82, further comprising reducing the lignin content of the biomass by at least approximately 90%.

85. The method of Claim 82, further comprising reducing the lignin content of the biomass by at least approximately 40%.

86. The method of Claim 82, further comprising producing paper or cardboard from the biomass after incubation.